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► To cite this version:

| Magali Chaudey. Contract Dynamics : Lessons from Empirical Analyses. 2010. halshs-00550346

HAL Id: halshs-00550346

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Submitted on 27 Dec 2010

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W P 1035

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Décembre 2010

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CONTRACT DYNAMICS: LESSONS FROM EMPIRICAL ANALYSES

Magali CHAUDEY*

ABSTRACT

The recognition that contracts have a time dimension has given rise to a very abundant literature since the end of the 1980s. In such a dynamic context, the contract may take place over several periods and develop repeated interactions. Then, the principal topics of the analysis are commitment, reputation, memory and the renegotiation of the contract. Few papers have tried to apply the predictions of dynamic contract theory to data. The examples of applications introduced in this article show the relevance of the change from a static contractual framework to a dynamic one. In a dynamic context, contracts are more sophisticated and can include commitment or a better revelation of the type of agent (insurance contract); contracts are more flexible (franchise contract) or offer a better measurement of information asymmetry and effort level (insurance or work contract).

CLASSIFICATION JEL: L14, C01, D81

KEYWORDS: Contract, Dynamics, Econometrics, Statistical Tests

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1. Introduction

For this article, we use P.A. Chiappori and B. Salanié's definition of contract theory (1997), according to which the theory describes the relationship between agents who seek to achieve a common goal through collaboration. This relationship leads to transfers between agents and a product. In its simplest form, the theory states that once the contract is signed, the parties can make decisions according to their own preferences and the terms of the contract. They become separate once more at the end of the contract. Several criteria enable us to distinguish different theoretical contract models, which can be structured according to the following: the nature of the information asymmetries; the preferences of each agent in view of the risks involved; the comprehensiveness of the contract; or the static *vs.* dynamic nature of the model.

The informational context is decisive for each contract model. This theory distinguishes two different types: adverse selection (where the information is incomplete) and moral hazard (where the information is imperfect). Adverse selection appears when the asymmetry bears upon the characteristics of the informed party. Moral hazard appears when the asymmetry bears upon the behavior of the agent or his effort. The principal-agent model is the most representative model of contract theory.¹ wherein these hypotheses of information asymmetry are associated with those of incentive and delegation.

In fact, contractual relationships are more complex than contract theory depicts, particularly because those parties involved in a contract meet on more than one occasion, thereby conferring a temporal dimension to that contract. This observation justifies the desire to inscribe contract theory within a dynamic framework that will allow the introduction of new concepts, such as commitment, memory or renegotiation, to the theoretical contractual framework.

This dynamic dimension for contracts was introduced by the theoretical literature in the 1980s. More recent econometric tests, carried out upon dynamic contracts, have established the importance of the background behind contractual relationships, as they seek to understand the determining factors of contractual models. This question of contractual determinants is identical to that raised by the empirical studies in the static framework, but the characteristics of the informational context and the tools that are available for the evaluation of the informational asymmetries are different. One

1- The framework for contract theory that has been retained for this article excludes the theory of transaction costs from its field of analysis (B. Salanié [2005], P. Bolton and M. Dewatripont [2004]).

fundamental question for studies developed in a dynamic framework is that of the distinction that exists between adverse selection and moral hazard; such a distinction cannot be made empirically within a static framework.

We aim to show how the empirical analyses envisage different integration modalities for the temporal dimension. The first modality involves studying panel data to measure the evolution of some variables in time and according to each individual; therefore, it will be possible to evaluate variables that are immeasurable (or poorly measurable) within the static framework.² A second introductory modality for contract dynamics begins with the hypothesis that certain variables have, by definition, a historical dimension, such as the bonus-malus system for car insurance, which takes into account the policy-holder's past accident history.

Whether the studies are carried out within either a static or a dynamic framework, the problem remains the same: to understand the factors that determine the choice of contracts, given the informational context and the characteristics of the contracting parties, and measure their effect upon their remuneration. By reviewing the empirical literature on contract dynamics, this article aims to demonstrate the relevance of a transition toward a dynamic context. It endeavors to understand how enriching these studies are by comparison with those carried out within a static framework and to pinpoint the specific nature of contracts according to the sector in question. The originality of this review is to insist on the dynamics of the contracts and the associated applications, focusing neither on a particular sector nor on a single informational framework.³

In the second part of this article, we will recall the static framework of contract theory and its derived empirical analyses. In the third part, we will show how the analysis of dynamic contracts has made a contribution, especially to the differentiation between adverse selection and moral hazard. In the fourth part, we will present the dynamic framework and its associated applications. We have retained the applications to insurance contracts, labor contracts and franchise contracts. The final part will present our conclusions.

2- An example is the measurement of a worker's effort level, through the observation of his career, which is supposedly in correlation with his past efforts.

3- For a survey on empirical literature concerning insurance contracts (adverse selection), see the study by A. Cohen and P. Siegelman [2010]

2. The Static analysis of contracts: characteristics and main limitations

2.1. The theoretical framework for static analysis

Contract theory defines a relationship between agents who seek to achieve their goal through collaboration. This relation generates a product and leads to transfers between agents. From this framework, there derives a general hypothesis that there is a relationship between the contract model, the performance of the contractual relationship and the resulting transfers between agents. Such a hypothesis may be subjected to testable predictions and empirical applications.

For these tests to be successful, three types of information are necessary: (i) the characteristics of each agent, which are known to the other parties (verifiable variables), (ii) characteristics of the contract, specifically the transfers carried out between the agents (wages, dividends, insurance bonuses, for instance), (iii) results of the relationship, or performance, which, depending on the context, may be in terms of the production level, profit or the accident frequency.

For static analysis, the hypothesis according to which a correlation exists between the results of the relationship and the transfers may take two different forms according to the nature of the informational asymmetry. In the context of moral hazard, one would expect remuneration to be connected to the performances of the relationship whilst being less volatile than those performances. Indeed, the principal, or the uninformed party of the contract, has no guarantee that the recorded performance is entirely the result of effort (and not merely a stroke of good or bad fortune). To rule out any doubt, the remuneration and performance need to be positively correlated, but not proportional. In a context of adverse selection, the agents reveal themselves by opting for a contract, which has been elaborated in such a way as to take their own characteristics into account and therefore produces different results. In this instance, a correlation between performance and transfers may be expected, and it is the informed party who, by means of the contract, will decide the intensity of the relation between these two variables.

2.2. Econometric applications

There are many empirical applications of contract theory within a static framework. They are generally related to labor, insurance, franchise, agricultural contracts or auctions mechanism. These applications are usually concerned with questions relating to the choice of contract design, given the informational context. Such questioning highlights the importance of the empirical measurement of information asymmetries. Within this static framework, the test evaluates the contract's level of dependency *vis-à-vis* the agents' heterogeneity, whether it be through an agent's characteristics, *i.e.*, the risk level presented by the agent (adverse selection) or through his behavior, *i.e.*, the occurrence of a risky event (moral hazard). From an econometrical point of view, what is being tested is the correlation between a risk and a type of contract (J.H. Abbring, P.A. Chiappori, J.J. Heckmann and J. Pinquet [2003]), without any possibility of distinguishing between adverse selection and moral hazard from an empirical point of view.

There are many econometrical tests carried out upon insurance data. Insurance companies have access to comprehensive data concerning the characteristics of both the insured persons and their contracts. Furthermore, Insurance is one of the rare sectors in which the result of an insured person's actions is easily accessible. M. Rothschild and J. Stiglitz [1976] were forerunners in the work carried out upon informational asymmetries in Insurance. In their article, the authors present the case of an insurance market where two types of people can be found: low-risk and high-risk individuals. The type of each agent is stipulated. The equilibrium of this market is such that, the high-risk agents choose total coverage, whereas the low-risk agents prefer the less expensive partial coverage. These low-risk agents therefore accept being under-insured to avoid being over-charged. High-risk agents make the opposite choice. They opt for total coverage because a reduction in their insurance costs is not a sufficient incentive for them to prefer partial coverage, in view of their type.

Within a static framework, the modeling of adverse selection leads to agents being presented on the basis of constant parameters, reflecting qualities that are known only to themselves. Adverse selection is then tested using cross-section data, thereby allowing a possible correlation between those parameters and the choice of contract or the occurrence of a risk.

The tests that have been devised in a static framework for adverse selection follow the work of M. Rothschild and J. Stiglitz. Based upon the hypothesis that the insured person is more aware of his own risk factors than the insurer is, P.A. Chiappori and B. Salanié [1997] test the following hypothesis: if equilibrium exists, it will be separating, in the sense that the insurance company offers the insured person to choose among a menu of contracts. The contracts vary according to the cost and the level of coverage. A higher level of coverage is associated with a higher cost and *ex post* a greater risk factor. When an agent chooses his contract, he reveals his level of risk.⁴ From an econometrical point of view, this hypothesis basically tests the correlation between an equation relative to contract choice and another one concerning occurrence of accidents. Where there is no correlation one may conclude that there is no adverse selection. Chiappori and Salanié's method is representative of the static method of testing for correlation between contract choice and informational asymmetries.

Given two probit equations, the first concerning the choice of contract and the other concerning risk occurrence,

where $i = 1 \dots n$ represents the insured persons,

$$y_i = 1 \text{ if } y_i^* = \beta X_i + \varepsilon_i > 0 ,$$

$$\text{Otherwise } y_i = 0$$

This probit concerns the choice of contract with $y_i = 1$, where the insured person chooses total coverage at the beginning of the year and 0 otherwise. X_i represents all of the exogenous variables that may be observed by the insurer and which enable us to characterize the person i . β is the parameter vector, which enables us to conduct an estimation, and ε_i is the error term, which enables us to grasp the agents' unobserved heterogeneity, once the observable variables have been taken into account. However, this may just be a reflection of the agents' differing positions *vis-à-vis* the risk.

$$z_i = 1 \text{ if } z_i^* = \gamma X_i + \eta_i > 0$$

$$\text{Otherwise } z_i = 0$$

This probit concerns accident occurrence with $z_i = 1$, where the insured person has an accident during the year and 0 otherwise; γ is the vector of the parameters which need to be estimated and η_i is the error term, which allows for the unobserved heterogeneity of the risk borne by the agent.

4- It may be noted that, where there is a correlation, it is possible to deduce that the insurer's price scale policy varies according to the type of person insured.

When informational asymmetry exists, it appears with a positive correlation between y_i and z_i conditional to X_i , which is the equivalent of a correlation between ε_i and η_i . Where the hypothesis is null ε_i and η_i are not correlated, the two probit equations are independent, that is, the contract choice and the occurrence of accidents are not related, and there is no problem for adverse selection. From an econometric point of view, the test may be carried out in three different ways (Chiappori and Salanié, [1997] and [2000]).⁵

- (i) The first is to test two probit equations independently and then test their independence *via* a score test.
- (ii) The second is to evaluate the two probit equations simultaneously by constructing a bivariate probit, which will account for the fact that unobservable factors are inter-correlated. The bivariate probit estimates the correlation ρ between the two error terms of the equations.
- (iii) The third possible test is based upon the hypothesis that the two preceding tests are too dependent upon the chosen functional form (linear model, parametrical framework). The non-parametric approach consists of combining the different parameters which define agent profiles. A contingency table is then made up, regrouping agents with identical characteristics in each cell. For each agent category, the correlation between agent characteristics and contract type is then tested using a chi-squared test.

The various empirical studies carried out for the car insurance sector show that there are no adverse selection problems. This result has been verified with French data (P.A. Chiappori and B. Salanié [2000]) and data from Quebec (G. Dionne, C. Gouriéroux and C. Vanasse [2001]). This absence of adverse selection can be explained in various ways. Theoretical models suppose an asymmetry of information favorable to the insured party. However, this assumption is often unrealistic: the policy-holder himself has imperfect information (ignorance of some of his characteristics, incapacity to associate his characteristics to his probability of accidents). In some cases, private information is held only by part of the population of reference; for example, the experienced drivers are better informed on their type than beginners. This explanation

5- In the article written in 2000, P.A. Chiappori and B. Salanié worked on a population of young drivers. As this population was relatively homogeneous there were fewer issues of heteroskedasticity, and the driver's experience (or lack of) brought no bias to the evaluations (young drivers' different levels of experience are not taken into account which us allows one to dispense with the question of no-claims bonus – surcharge). The other specificity of the tests carried out for this article is that the risk occurrence is measured by the number of accident reports and not the accidents themselves. The choice to report an accident or not, however, lies with the insured person, and this choice is strongly related to the type of contract. In other words, a non-covered accident will not be reported! This *ex post* moral risk generates a correlation between the type of contract and the probability of there being a report, even when there is no *ex ante* moral risk.

justifies, in particular, that the results of A. Cohen [2005] are different from those previously presented. On Israeli automobile insurance data, the author concluded the presence of adverse selection. However, this adverse selection is recognized on the subsample of the drivers with more than three years of experience and not on the young drivers. Another interpretation of this result might be that insurers are able to interpret informational asymmetry problems correctly and are, therefore, able to offer contracts menus that are likely to minimize the occurrence, especially in the competitive insurance market, when insurers are able to offer a wide choice of contracts (K. Saito [2006]).

Beyond the empirical approach, which has been suggested previously, the general teaching of contract theory is that, within an adverse selection framework, the agents who are observed are supposedly identical and are faced with a number of contracts menus from which they are free to choose. Among these menus, the contracts offering greater coverage are chosen by agents presenting a greater risk, that is, a higher probability of accident or illness. These contracts are sold at a higher cost; in other words, the marginal cost rate⁶ should increase with the level of coverage. The contracts menu enables the insured person to reveal his type.

If we consider the context of moral hazard, we must assume that the choice of contract will affect the insured person's future behavior. The agent with a high risk factor who has chosen a high coverage level is likely to be less cautious. The probability of a risk event occurring is therefore higher. In the specific case of insurance contracts, moral hazard refers to the impact of insurance upon the call for limiting risks. As with cases of adverse selection, there is a need to test the correlation between the types of contract and risk.

Ultimately, the theoretical models upon which these tests are based assume that there is informational context that only grants empirical studies the option of correlating contracts with risks. As A. Cohen [2002] points out however, highlighting a correlation between the type of coverage and the number of accidents merely signifies that the hypothesis of moral hazard cannot be rejected. However, both moral hazard and adverse selection reveal a coverage-accident correlation; from an empirical stance, it is difficult to distinguish between the two forms of asymmetry. The studies carried out within a static framework are, therefore, obliged to state the nature of the

6- This rate is assimilated to the necessary increase in the cost of the insurance coverage for each additional monetary unit.

asymmetry as a working hypothesis, as for example, do P.A. Chiappori and B. Salanié, [1997] and [2000].

The applications of contract theory within a static framework are also confronted with some econometrical difficulties. One serious problem concerns the measurement of the key variables in this theory, in particular that of effort in a moral hazard model. It is true that, as the theoretical models show, this variable is unobservable not only by the principal but also by the econometrician. Another important problem in these studies is the endogeneity of choice for the type of contract: for many models, there is an attempt to identify the contract's determining factors, the design of which, however, is assumed. Similarly, for certain applications, the question is centered upon the factors that determine the choice of contract (sharecropping *vs.* fixed rent contracts, franchise *vs.* owned units) when the underlying question of production delegation is not even broached.

Some of these econometrical problems may be overcome by the applications that have been developed within a dynamic framework, even though the primary motivation for these applications remains the construction of a more realistic working framework.

3. Informational asymmetries within a dynamic framework

Contractual reasoning within a dynamic framework has significantly renewed the way that informational asymmetries are represented. In the context of adverse selection, the dynamic theoretical models may render static models more complex in two different ways. Either one assumes that the agent's type does not change over time and in which case carrying the contract out allows information to be revealed, which then leads to the contract being renegotiated, or the agent type does change over time,⁷ which then raises the question of how the sharing of risks between the contract parties evolves as well as the smoothing of incomes over time.

In a moral hazard context, the dynamic models have three characteristics. First, the agent is incited to take more risks because he is partially insured against the loss of income thanks to the smoothing of his income over time. Secondly, the principal acquires more information concerning the agent's behavior thanks to his regular

7- If the agent's type changes, then so too does his reservation utility, which renders the maximisation program more complex, as it is defined in static contract theory models.

observation of that behavior. Finally, a long-term contract may be more effective than repeated spot contracts, as the agent has to manage different periods (in terms of savings or consumption, for example).

3.1 Adverse selection and moral hazard within a dynamic framework

Several studies using dynamic data assume the hypothesis that it is possible to distinguish between adverse selection and moral hazard. According to P.A. Chiappori, [1994], differentiating between moral hazard and adverse selection brings us back to a causality problem. In a moral hazard context, people's (unobservable) actions that affect the contracts' performance are the result of the contracts' form. For instance, a contract could be the cause of an increase in risk because the encouragement for caution is diminished (G. Dionne [1998]). In the context of adverse selection, the differentiated nature of the risks precedes the drawing up of the contracts: the choice of contract is the result of the type of risk that best represents the insured person. There is indeed a form of inverted causality between these two informational problems.

The tests for distinguishing between moral hazard and adverse selection presented in the empirical literature consist of simultaneously analyzing the processes that determine risk occurrence and choice of contract. These aim to identify the variables that may be able to explain these two processes and the time lag that exists between them. The question that arises is that of discovering whether it is the risk that determines the choice of contract (adverse selection) or whether changes in contract clauses engender changes in behavior (moral hazard). There are two possible approaches. First, we may assume that the form of the optimal contract differs according to the informational contract. We then seek to identify the contracts' qualitative characteristics to discover the nature of the informational asymmetry that each contract is supposed to correct. A second approach assumes the existence of contracts (possibly sub-optimal) and studies their influence upon observed behavior (for example one might observe the influence of a contract upon the driver's behavior, which includes a bonus-malus clause and reaches the conclusion that there might be a moral hazard problem).

For J.H. Abbring, P.A. Chiappori and J.Pinquet [2003], using dynamic data to distinguish between adverse selection and moral hazard, constitutes a problem similar to that of distinguishing between state dependence and dependence *vis-à-vis*

unobserved heterogeneity (J. Heckman [1981]). On the one hand, moral hazard refers to a particular case of dependence upon the state: in the same way that an individual person is more likely to become unemployed if he already has been in the past, an individual person who has had several accidents in the past has a higher risk of having another in the future. The bonus-malus system may therefore be defined as a specific case of state dependence. On the other hand, adverse selection refers to the particular case of dependence upon unobserved heterogeneity: the person's individual characteristics change over time and condition the choice of contract and therefore risk occurrence. In the same way individual characteristics may explain a person's present and future employability.

3.2 The econometric tools to differentiate between adverse selection and moral hazard

Within a dynamic framework, it is possible to see that there are many tools that enable us to distinguish between adverse selection and moral hazard. One tool involves taking the driver's experience into account and considering it specifically as a variable that might explain the risk factor. In which case, tests for correlation between contract and risk are able to measure informational asymmetry. By the same logic, it may well be relevant to take the driver's learning history into account, as through experience, he will have acquired information concerning his own level of risk and may thus make a better choice of contract from the menu of options that he is being offered.

A second tool involves studying panel data to comprehend the "history" of the contractual relationship. This historical dimension enables us to distinguish between moral hazard and adverse selection, as the qualitative characteristics of the contract vary according to the two different informational contexts. In the context of adverse selection, the contract has a monotonous memory (past performances have equal weight). For moral hazard, the memory is more of a "short-term" nature and concedes more weight to recent events. Empirical analysis shows that, *a posteriori*, contracts may enable us to distinguish between these two contexts (P.A. Chiappori and J. Heckman [2000]). Under the bonus-malus system, the cost of an accident in terms of future premiums depends on the number of previous accidents. In the context of moral hazard, one expects a negative correlation between claims in t_1 and accidents in t_2 , because the bonus-malus system incites the driver to be careful. Under adverse selection, in contrast, a negative correlation is expected. Indeed, accident claims in t_1

show a high-risk driver, and this characteristic can explain the number of accidents in t_2 (A. Cohen and P. Siegelman [2010]).

This review concentrates on three representative types of contract: the insurance contract, the labor contract and the franchise contract. In our opinion, such a choice is justified due to the extensive and comprehensive information that the insurance sector provides for empirical studies. The implementation of labor contracts is based upon problems that are in touch with the more theoretical framework (contracts with memory and renegotiation) and which offer original solutions for the measurement of effort levels. Finally, studies carried out upon franchise contracts can be generalized following the analysis of the dynamics governing other forms of inter-firm contracts.

We will demonstrate that, depending upon the type of contract, the determining variables may change: in the case of insurance, the influence of informational asymmetries is clear (repeated adverse selection or moral hazard). In the case of labor contracts, it is the contract memory and the access to credit that are the determining variables. Finally, for the analysis of franchise contracts, the main concern of the relevant literature is the maturity of the network and the contract clauses.

4. The empirical analysis of dynamic contracts

Beyond the static framework, contract theory includes the idea that a contract is usually carried out over several periods and gives rise to repeated interactions. This amounts to stipulating that a contract may have a dynamic dimension (D. Fudenberg, B. Holstrom and P. Milgrom [1990], J. Malcolmson and F. Spinnewyn [1988], P. Rey and B. Salanié [1990], W. Rogerson [1985]). As soon as one begins to take an interest in theoretical dynamic models, the themes that are developed are commitment, reputation, memory or renegotiation.

When it is applied to a contract, the distinction between the static and dynamic frameworks may be based on the analysis of different types of commitment. B. Salanié [2005] differentiates between four types: (i) spot commitment, when the contract only holds for the current period; (ii) full commitment, when the contract that has been signed covers the whole duration of the contract and may not be renegotiated or breached; (iii) long-term commitment with renegotiation, where if the contract covers the whole duration of the relationship and can be renegotiated multilaterally, it can

only be renegotiated if all of the parties agree; (iv) short-term commitment, with a time-limit and which includes all of the intermediate cases between spot commitment and long-term commitment. Only long-term commitment is in fact situated within a dynamic framework, its particularity being that it allows information to be disclosed gradually.

When the contract is a long-term one, it is preferable that the principal signs a complete contract⁸ that covers the whole duration of the relationship. Therefore, there can be no renegotiation,⁹ which might lead to a sub-optimal solution. Nevertheless, it is possible that when the parties are engaged in a long-term contract, certain clauses may reveal themselves to be ineffectual *ex-post* because they are inappropriate for the evolution of the contractual relationship. The passage towards the dynamic framework enables a more realistic representation of the commitment and the associated contract as well as a better control of informational asymmetries.

4.1. Insurance contracts

Due to the informational asymmetries that concern the characteristics and behavior of the insured people, the insurers offer contracts menus that are likely to reveal hidden information. If the contract takes place over a single period, the insurers develop pricing and discriminatory coverage techniques. The idea then is to offer contracts menus in which the premiums and the coverage are positively correlated. Therefore, people who are at risk choose a contract with extensive coverage and a high premium. However, these single-period contracts do not give the insurers access to all of the information necessary for them to provide the best contract offer. For instance, past incidents are determining factors that encourage the insured person to reveal his *ex ante* risk level through his choice of contract.

For some time, theoretical insurance models have shown that past experience rating, which is a variable that can be considered a personal characteristic, is a means of reducing problems of adverse selection (G. Dionne, N. Doherty and N. Fombaron [2000]) and moral hazard (R. Winter [2000]). This pricing system is widely

⁸- A contract is complete if it takes into account all the states of the nature which are or will be necessary throughout the duration of the contract.

⁹- Within a long-term context, renegotiation is considered to be a consequence of the agents' opportunism.

implemented in car insurance through the bonus-malus mechanism. This method of analyzing pricing is based upon a dynamic representation of insurance contracts.

4.1.1. The repeated adverse selection framework

Within a dynamic framework, adverse selection emerges continuously. Empirical studies test the relationship between a risk's occurrence sequences and the choice of contract. For instance, agents who learn that their risk level is on average higher to that of the rest of the population are more likely to change contract in favor of one with a better coverage. When adverse selection is repeated over several periods, the disclosure mechanism becomes more complex and even less efficient.

The article written by R. Cooper and B. Hayes [1987] is one of the first to look into bi-periodical insurance contracts. These authors propose a repeated adverse-selection model where the simple selection model is repeated from one period to the next. The contract is perfectly defined, and both the insurer and the insured person may commit on the basis of their future behavior. This is a long-term contract with total commitment. The authors conclude that it is necessary that an insurer offer dynamic contracts pooling to deal with the question of adverse selection. Their main result is that there is equilibrium when people with a higher probability of having an accident opt for a full-insurance contract. This contract is independent from past accidents and therefore remains unchanged in time. To those people with a lower accident probability, the insurer will offer a partial insurance contract, priced according to their level of experience. Indeed, it is in the best interest of this category of insured person to disclose his type and experience, thereby ensuring for himself a lower insurance premium.

Cooper and Hayes do not subject their results to an empirical analysis. Their approach does, however, deserve some consideration, as it opens the field to other studies on multi-period contracts, in particular that of G. Dionne and N. Doherty [1994]. In this article, Dionne and Doherty apply J.J. Laffont and J. Tirole's model [1990]. They set their reasoning within a framework of competition between different insurance contracts based upon a bi-periodical model with unilateral commitment: the insurer may commit to keeping a client, whereas the latter remains free to choose another insurer. Within such a context, the authors demonstrate that the best long-term contract including renegotiation is one that differentiates between the first and

second periods and is thus qualified as a partial commitment. During the first period, the contract is a *pooling* contract, that is, there is total coverage for high-risk agents and partial coverage for those who are at less risk. At the beginning of the second period, the insurer offers two pairs of contracts: one pair for the insured people who have had an accident during the first period (regardless of whether they are high- or low-risk clients) and one pair for those who have not had any accidents. The offer made for the second period takes the information gathered during the first period into account which incites the insured people to further disclosure at the onset of the second period. In this model, we may note a tendency to reduce the problem of adverse selection due to the accumulation of information over time. Dionne and Doherty's model was tested upon Californian data for the 1985-1987 period. The results show that some companies do indeed choose partial commitment strategies to attract low-risk clients who are more inclined to change companies according to the prices that they offer. Therefore, Cooper and Hayes' theoretical conclusions are validated: the information which is collected favors the defining of contracts that are more in keeping with the agents' characteristics and thus encourage them towards disclosure. Such disclosure contributes in turn to defining contracts that are appropriate to the risk level of each agent.

4.1.2. The repeated moral hazard framework

By hypothesizing that the agent's strategy is stable in time in terms of effort, a sufficiently long observation of that effort will enable the principal to infer with increasing accuracy what the agent's choice will be. Therefore, the principal may conceive an appropriate sanction system to reach an allocation that approaches the *first-best*. Such a framework was developed by A. Rubinstein and M. Yaari [1983], who demonstrate that if neither the principal nor the agent have a preference for the present situation, then a first-best equilibrium has been achieved, assuming that the interaction between the principal and the agent may be repeated *ad infinitum*.

The article written by P.A. Chiappori and J. Heckman [2000] is rooted in a framework of repeated moral hazard. The authors present the experience as a determining variable for defining the contract in such an informational context: an accident will impact the forthcoming premium; if the memory is long, then the impact will have repercussions upon the whole range of future premiums. Within a moral-

hazard framework, the insurance price scale presents a correlation between the insurance premium and the accident process.

The authors' intuition is that, all things being equal, the optimal effort level should increase along with the cost of the premium; that is, a higher premium should incite the insured person to more caution, as caution ought to reduce the probability of a forthcoming accident. However, the existence of an unobserved heterogeneity may cause an opposite effect: good drivers pay lower premiums as they have had fewer accidents in the past. Furthermore there is a lower probability of their having any future accidents. In this case, it is the low premium that creates the incentive towards effort. The premium is associated with the insured person's characteristics (adverse selection).

Econometric studies allow a distinction to be made between the two cases. Differentiating between adverse selection and moral hazard amounts to identifying an eventual unobserved heterogeneity, which is typical of the adverse selection framework. Therefore, the testable prediction is as follows: by controlling individual characteristics (including unobserved heterogeneity), the risk of an accident occurring should increase over a period without any accidents and then decrease after an accident. Various tests may be envisaged according to the availability of the data. (i) In the most favorable situations, the econometrician has the exact date of the accident; accident occurrence may then be modeled within a continuous time frame using a duration model. (ii) In most cases however, the econometrician only has the information concerning the number of accidents over a given period of time (usually a year). For an agent i observed over t periods, the available data refer to the number of accidents and the year during which each accident occurred. Each agent is then identified over this t period by a series with a value of 0 or 1, and a dynamic analysis becomes possible. (iii) A final approach, which is minimalistic in terms of the available data, allocates a coefficient to each driver who has driven during the t periods and has had n number of accidents, regardless of the exact *timing* of these accidents.

When applied to case (i), the test stipulates that if moral hazard is recognized, then the probability of there being accidents, conditional to the observed and unobserved heterogeneity, should increase regularly over an accident-free period and then decrease following an accident. In case (ii), an additional hypothesis is introduced: during the observation period, the probability of an agent's having an accident remains constant. We then consider a set of agents having had identical series of accidents (identical duration and average number of accidents), although the order of the accidents is

different within the set. When the hypothesis is null (absence of moral hazard) these sets should all incur the same probabilities. This is not the case however, when moral hazard does occur: for each period, the probability of there being an accident changes according to the occurrences of accidents during the previous period. In situation (iii), the additional hypothesis is that the unobserved heterogeneity within the population is identical, no matter what the cohort observed. When the hypothesis is null, the probability of there being an accident is identical for all drivers, whatever their experience, no matter what the value of their coefficient may be.

In each of these cases, the accident dynamics are used to test the presence of moral hazard against the null hypothesis according to which accident probability does not depend upon the past behavior of the insured person. Chiappori and Heckman reach the conclusion that the null hypothesis cannot be rejected: accident probability depends not upon the past accident record of the agents but rather upon observable characteristics such as the age of the insured person or that of the vehicle involved.

4.1.3. Dynamic contracts and learning

Symmetrical learning is another informational hypothesis upon which the dynamic analysis of insurance contracts may be based. The contract parties do not know the risks that characterize the insured person. With each new period of the relationship, they learn by observing the results (for instance, the number of accidents during the period or an employee's performances) and, at the same time, adjust their knowledge (within the framework of optimal contracts). These models rely upon incomplete but symmetrical information hypotheses and upon learning.

I. Hendel and A. Lizzeri's article [2003] falls within this framework. Their study concerns life-insurance contracts. The insured people are presented as a heterogeneous group, and there is unilateral commitment. The authors demonstrate that, in the long term, for a given contract, high-risk insured people would do better to quit the contract as soon as their risk level becomes known. Similarly, low-risk people whose insurance premiums are highest given their type would also, in the long run, do better to opt for another contract. Therefore, the authors highlight the fact that the risk reclassification market does run efficiently if the insured person and the insurer symmetrically become aware of the insured person's risk level. Such a phenomenon reveals a weakness within the insurance markets. In equilibrium, it is therefore preferable that the insurance

contract should be *front-loading*,¹⁰ to reduce the better clients' incentive to quit the contract.¹¹ Hendel and Lizzeri validate the theory whereby *front-loading* contracts hold the consumer to the contract and introduce a form of insured party commitment, thereby limiting his mobility.

This idea of commitment may also be found in the article written by K. Crocker and J. Moran [1997], which is concerned with the health insurance provided by employers in the United States. Commitment in this case is represented by the difficulties that an employee may encounter when attempting to change jobs as, within the American system, health insurance is most often connected to employment.¹² In a theoretical approach, Crocker and Moran show that when an employer offers the same contract to all of his employees, then the optimal contract provides limited coverage, which is inversely proportionate to the barriers to job mobility (*Job lock*) encountered by those employees. If the employer is able, however, to offer a variety of contracts appropriate to his employee's characteristics, the optimal contract will include total coverage for medical care. The premium calculated for the second period can only be partially based upon the employee's state of health. These theoretical predictions are confirmed by the econometrical studies:¹³ firms whose insurance contracts only offer one type of coverage see that coverage decreases as the barriers to job mobility increase. Firms who offer their employees multiple contracts provide higher levels of coverage, in which case the coverage is independent of the employees' degree of job mobility.

The papers we have mentioned before introduce a symmetrical-learning hypothesis. This learning concerns the risk level of the insured agent but has no effect on the information asymmetry that exists between insurer and insured party. Some works set down that learning could favor one contract party. A. Cohen [2005] demonstrates that more experienced drivers benefit from a learning effect, which explains the presence of adverse selection for this sub-sample (correlation between insurance and risk).

¹⁰- A front-loading contract is structured such that one pays for a service that will only be used at a later date; this is the case, for instance, of care insurance.

¹¹- These clients are actually better than the contract initially anticipated.

¹²- The majority of Americans (60%) are covered by private health insurance, most frequently offered by the employers. Employees are free to choose whether or not they subscribe to the health coverage provided by their employer.

¹³- The econometrical test is a probit that is organised into three levels of health care. The sample consists of 8191 American employees and refers to the year 1987.

Other articles propose a different context for asymmetric learning. They postulate that experienced drivers would further underestimate the number of past accidents when they change insurance companies. Likewise, an insurer would be better off contracting with the same drivers from one period on the other. In this case, he has an informational advantage over competitors. The insurer achieves this advantage by learning.

A. Cohen [2008] examines this context. Her paper uses a rich dataset obtained from an Israeli insurance company, and the results are consistent with the predictions of the asymmetric-learning theory. (i) The insurer makes higher profits on policies he sells to repeat customers. (ii) These profits are driven by profits from repeat customers who have a clean record. (iii) These profits are generated not merely by charging these customers higher premiums but primarily by the lower costs that clean record policyholders impose on the company. (iv) The tendency of customers with bad records is to leave their insurer, so the policies of the pool of repeat customers are high quality. According to A. Cohen, the renewal of contracts allows the insurer to obtain better information concerning the insured party, to the detriment of competitors.

Applications carried out upon insurance contract data are far more numerous and more detailed. The sector affords a great diversity of contracts that are likely to uphold certain teachings of contract theory, in particular the importance of commitment within a dynamic context. The peculiarity of the contracts analyzed by the empirical literature is that they all reflect a part of the insured person's "history". Integrating this temporal dimension gives special qualities to these contracts: efficient control of informational asymmetries thanks to the insured person's commitment (*front-loading* contract or *job lock* system) or a more accurate disclosure of the insured person's type (contract *pooling*).

4.2. Labor contracts

Once contracts are considered in terms of a timeframe, it is logical to suppose that they have a memory. The idea of a contract having a memory was introduced by W. Rogerson [1985]. This concept was then taken up and applied to labor contracts by P.A. Chiappori and I. Macho-Stadler [1990] and to insurance by G. Dionne, M. Maurice, J. Pinquet and C. Vanasse [2001]. Their hypothesis is that the payment received by the

agent at the end of each period depends upon the relationship's past history (for instance, past performances) and upon the results for that period. The models for contracts "with memory" distinguish between "memory of consumption", if one opts for the agent's standpoint (the agent's consumption depends upon the payment he received during that, and preceding periods), and the "memory of wages", if one takes the stance of the principal (the salary paid for the present period being dependent upon past income). Chiappori and Macho-Stadler specify that according to the informational context, the optimal contract may or may not have a memory. When information is incomplete and symmetrical, the contract has a memory and takes into account the totality of past performances (each past performance contributing information to the unknown parameter). In the case of pure adverse selection, however, the optimal contract has no memory, and the principal simply repeats the same contract from one period to the next. Therefore, he commits to not using information gathered during previous periods, which the agent would otherwise be better off not revealing! In the case of repeated moral hazard, whether a contract has a memory or not depends upon other variables such as access to credit.

It is possible to test contract memory econometrically. More precisely, it is the absence of memory that is tested, *via* the lack of residual auto-correlation or the insignificance of a memory variable (career, promotion...).

The conclusions which are reached for repeated moral hazard clearly depend upon the characteristics of the financial environment, in particular those related to access to the credit market. Many models assume that the amounts transferred during each period have a direct influence upon the level of monetary consumption, which means that the money can neither be saved nor borrowed to increase its consumption level over time. W. Rogerson [1995] uses this hypothesis when he analyzes memory contracts. I. Macho-Stadler and P.A. Chiappori demonstrate that labor contracts change according to whether one assumes the hypothesis for access to credit. Where there is no credit market, or it is inaccessible, the contract's memory allows an income smoothing over time. For a given effort level, if the agent performs during a first period, this is due to favorable circumstances. The corresponding financial gain is therefore implicitly transitory. The agent then seeks to spread this supplementary gain over time, which is possible if the contract has a memory.¹⁴ The other necessary condition for such a smoothing over time is that the employer commits himself; that is, he offers a long-term contract.

¹⁴- The underlying hypothesis is that the employee's reservation utility remains constant over time.

The question, then, is to determine how this interpretation may be modified when the hypothesis of access to credit is introduced. If there is no rationing of the access to credit, then the agent may borrow any amount that he likes. In such case, the income smoothing takes place by relying upon this market. *“Thus, the needs of smoothing continue to explain the existence of a memory of consumption but are no longer linked to the memory of wage”* (P.A. Chiappori and I. Macho-Stadler [1990] p. 66). One possible method of making these memory contract models more complex consists of envisaging that the employee’s reservation utility is not stationary and that it increases as the employee increases his stock of human capital. Chiappori and Macho-Stadler’s work suggests avenues for econometric testing without actually implementing them in their article, written in 1990. This work is nevertheless important in that it reveals the significance of two variables that determine the analysis of the dynamics of labor contracts: contract memory and access to credit.

Other approaches have shown an interest in the dynamics of labor contracts, but within a different informational context, that of symmetrical learning. The precursory model for symmetrical learning when applied to labor contracts, is that of M. Harris and B. Homlstrom [1982], in which it is supposed that, at the beginning of their relationship, an employer and his employee are both unaware of the employee’s skills. They both learn at the same rate from observing the employee’s performance.

P.A. Chiappori, B. Salanié and J. Valentin [1999] apply this model to the analysis of internal labor markets and use two of Harris and Homlstrom’s hypotheses: symmetrical learning and downward rigidity in wages.¹⁵ From tests carried out over a period of 15 years on 1,000 executives working for a large French public company, they show how optimal contracts have a *late beginner* effect. This effect conveys the idea that if two agents A and B are at the same total wage in t_0 and t_2 but that A has a higher salary in t_1 , then B’s wage prospects and career will become more interesting during t_3 and subsequent periods. B is then qualified as a *late beginner*. This approach introduces an analysis in terms of career, which is defined from the sequencing of successive promotions. The career is assimilated to a measurement of employees’ performance. This study demonstrates that there exists a correlation between performance and contract type (wage): the employer modifies the contract in relation

¹⁵- Downward rigidity in wages may be justified either by the will to share the risks between the employer and the employee or by a hold-up problem when the contract is incomplete.

to the employee's career by giving more weight to his most recent results. The memory is non-monotonous, and there is clearly a learning phenomenon.

We may now finally speak about how a dynamic framework may be applied to the analysis of manager compensation (M. Margiotta and R. Miller [2000]). This article addresses the policies governing managerial compensation in large companies and their impact upon incentives. The problem is based upon a multi-period principal-agent model including moral hazard. The context of moral hazard may be justified in this case due to the fact that the shareholders have delegated their decision-making power over to the managers and due to the formers' inability to observe the latter's behavior directly. The econometrical tests are carried out upon a sample of managers¹⁶ covering 34 firms, between 1948 and 1977. Based upon the analysis of panel data, Margiotta and Miller's main conclusion is that there exist many advantages to presenting managers with greater incentives and the cost of those incentives is relatively low: generally, a small fraction of the firm's shares is sufficient to induce the required effort level. This conclusion is rather similar to that of studies carried out upon cross-sectional data, although the test carried out upon longitudinal data are more robust and reduce selection problems.¹⁷

There are fewer empirical analyses concerning the dynamics of labor contracts than there are of insurance contracts, as it is without any doubt more difficult to access the data. These studies do, however, single out an important theme that is introduced into the theoretical dynamic models: that of contract memory, which may be represented, for instance, by the employee's career. These works open up important avenues for future study, particularly in relation to the measurement of effort. Statistically, this measurement can be delicate and, more often than not, requires the use of proxy variables such as qualifications. Studies concerning panel data allow a more accurate evaluation of effort levels via the construction of career variables or the measurement of employees' performance over time.

¹⁶- Only the three highest-placed managers within the firm's hierarchy are taken into account.

¹⁷- The selection problem is more obvious with cross-sectional data. In this instance, the problem is linked to the fact that the incentive level included in the manager's contract depends strongly upon the firm's results and yet at the same time determines those results.

4.3. Franchise contracts

Contract theory has been widely applied to the analysis of franchise contracts (F. Mathewson and R. Winter [1984], [1985 a], [1985 b], P. Rey and J. Tirole [1986a] and [1986b]). Most frequently, however, the reasoning for such contractual franchise analyses comes within a static framework. With the exception of only rare articles, there are few elements concerning the dynamics of franchise networks and concerning the learning process within these networks.

Although the first two articles to be presented privilege a theoretical approach, they open up avenues for further empirical analyses. F. Mathewson and R. Winter [1985 a] have developed a reputation model where the royalty rate and franchise fees are reduced for young networks that do not yet have an established reputation. More generally, they specify that the royalty rate ought to decrease and the franchise fees increase as the network's reputation becomes more solid. Mathewson and Winter's approach is not dynamic *a priori*; it becomes so when a reputation variable is introduced, which by definition has a temporal dimension. P. Rubin's "dynamic" approach [1978] leads to other conclusions. According to Rubin, over time, a franchisor has a tendency to increase the royalty rate for his network to compensate for the decrease in income, which is inherent to market saturation.

In an article that is both theoretical and empirical, N. Gallini and N. Lutz [1992], question the reasons for choosing a dual distribution¹⁸ mode within a network. The idea defended here is that the percentage of units held by a network is an indication of its profitability. By holding its own units, the franchisor conveys information concerning the demand level for the product, which is even more important when the product is new on the market or of a high quality. The predictions made by the model are that over time, the percentage of owned units and the level of royalty rate should decrease, insofar as the information that is disclosed concerning the franchisor and his product improves (at the same time, one would expect an increase of franchise fees). In other words, the characteristics of the contract change as the network gains in maturity. Gallini and Lutz propose a simple dynamic model with two periods, where information is disclosed at the end of the first period.

The three approaches presented have in common the introduction of a dynamic approach to franchise contracts within a framework, where the problems remain static.

¹⁸- One speaks of dual distribution when, within the same network, franchised units coexist along with units which are held by the franchisor himself (owned units).

More specifically, it is by introducing the question of the networks' maturity that the three models acquire a dynamic dimension. F. Lafontaine and K. Shaw's article [1999] is different from previous works in that their empirical studies are carried out within a framework that is dynamic right from the start. By applying contract theory to panel data,¹⁹ Lafontaine and Shaw seek to answer three main questions. (i) How do firms modify the terms of their franchise contract as they gradually become established on the market? (ii) To what extent may the terms of the contract be explained by the firms' individual characteristics (fixed effects)? (iii) What is the relationship between the royalty rate (continuous payment variable) and the franchise fees (fixed payment)? The econometric evaluations²⁰ allow three important conclusions to be drawn. Whatever the size of the network or the levels of the royalty rate and the franchise fees, there is a definite stability of the contract terms over time. Networks that change their franchise fees do not necessarily change the levels of their royalty rate when they become more mature. This conclusion differs from those studies that were mentioned previously. Lafontaine and Shaw note that the changes made to sharing clauses may essentially be explained by those characteristics that are specific to the networks and not by their maturity.

The relevance of the studies carried out upon the dynamics of franchise contracts enables us to envisage a generalization of this type of approach to other examples of inter-firm contract. The dynamics of franchise contracts highlights the role played by the contract clauses as variables for the adjustment of the network's changing characteristics or for those of its environment. This dynamic approach to franchise contracts could then be extended to analyzing the flexibility of the different types of contractualized inter-firm organizations. Whatever the type of inter-firm contract to be considered, the question still remains that of constituting data bases in general and panel data in particular, given the recurring difficulties that exist when trying to access contract data.

¹⁹- The sample concerns 1,000 American franchise networks, observed between 1980 and 1992.

²⁰- Lafontaine and Shaw test a parametrical model of the type: $R_{it} = \beta X_{it} + \mu_i + \varepsilon_{it}$, where R_{it} is the royalty rate ; X_{it} is the number of years (at time t) since firm i began franchising; μ_i represents the characteristics that are specific to the firm (its technology, the value of its concept on the market, the quality of its management...); ε_{it} is the error term. Lafontaine and Shaw propose four estimations: two OLS regressions (one on the royalty rate and one on the franchise fee) and two fixed effects models (one on the royalty rate and one on the franchise fee).

5. Conclusion

The various examples of applications that have been presented highlight the relevance of moving from a static contractual framework to a dynamic one. This change of context brings yields contracts that are more sophisticated (insurance contracts), more flexible (franchise contracts) and that offer a more accurate measurement of informational asymmetries or effort levels (insurance or labor contracts) than those described in the studies carried out upon static data. Nevertheless, to date, few articles propose applications of dynamic contract theory and there may be several reasons for this. For one, the theoretical framework is demanding and rarely compatible with the available data. However, some key concepts of dynamic contract theory are explicitly used in econometric studies: commitment, renegotiation, and contract memory. Furthermore, access to data is one of the major difficulties encountered in empirical studies carried out on contracts, whether these studies are within a static or a dynamic framework. This problem with accessing data would explain the gap between the progress that has been made in the theoretical field and its applications, which, although there has been development, still lags behind. Progress in the field of modeling dynamic contracts is hindered by the gap between the theoretical and empirical approaches; the confirmations or invalidations that result from the empirical studies are of no benefit.

Despite these limitations, the avenues for research that have been opened up by the empirical studies carried out upon contract dynamics are promising. The results that have been achieved thus far enable us to envisage further study of the applications that have been presented and perspectives in other areas. The analysis proposed by Ph. Gagnepain, M. Ivaldi and D. Martimort [2009] is representative of this renewal. This analysis concerns the urban transportation sector in France, where contract theory has already studied, but rarely in a dynamic context. The authors keep the incentive theory framework but add a regulatory mechanisms *à la* Baron and Myerson [1982]. Furthermore, this approach presents a strong link between the theoretical model and the empirical application. Lastly, this analysis has a rich dataset (136 contracts observed between 1987 and 2000), presented as a series of contracts.

The analysis of agricultural contracts offers also interesting perspectives. These contracts have been subjected to numerous applications of contract theory, in particular where the problems surrounding sharecropping and tenant farming are

concerned.²¹ Most applications remain within a static framework (the contract is only analyzed over a single season). A few studies have touched upon a dynamic approach (B. Dutta, D. Ray and K. Sengupta [1989], G. Bose [1993]), but this approach has still to be developed.

With franchise data, the information, which is collected on a European scale, is increasing and becoming more precise in terms of the characteristics of contract clauses, and it is now possible to envisage the construction of a data panel. On a wider scale, it is conceivable that certain concepts inherited from the application of labor contracts or developed within the insurance framework may be incorporated into the analysis of the dynamics of vertical contracts. The question of contract memory, for instance, is particularly interesting for the analysis of vertical contracts. Indeed, we may question the nature of the memory prevailing in a vertical relationship and assume that the choice of contract clauses depends upon the quality of the memory to be included in the contract or the effective level of that memory. As with the static framework, the contractual clauses would be presented as modalities for incentive and the homogenizing of behavior within a network. By placing itself within a dynamic framework, however, the analysis is enriched when it takes into account the time gap that may exist between incentive and effort.

²¹ With a fixed-rent contract, the landowner hires his land out to a farmer for a fixed price. With a share-cropping contract, the landowner and the farmer agree to share the production at a certain rate, which is often supplemented by a lump sum payment.

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